Saskatchewan
Agriculture
and Food

ADF

AGRICULTURE DEVELOPMENT FUND

FINAL REPORT

20020218

ADDING VALUE TO OILSEED FLAX PRODUCTION IN SASKATCHEWAN WITH FIBRE AGRONOMY

Funded by: The Agriculture Development Fund

January, 2006

Prepared by: East Central Research Foundation

Title: Adding value to oilseed flax production in Saskatchewan with Fiber Agronomy

Byron Irvine AAFC Brandon, Jody McConnell SAF Agri-ARM Coordinator, Gordon Hultgreen, Pami Humbolt, Alvin Ulrich Biolin, Saskatoon, Bill May, Guy Lafond, AAFC Indian Head, Kim Stonehouse ECRF Canora, Scott Chalmers SERF Redvers

Summary

When flax was planted at recommended seeding rates for oilseed flax production seed; neither seed nor fiber yields were affected by the seeding tool used. This differs significantly from long line fiber production in Europe where narrow row spacing is practiced. This is positive for producers who can use their existing seeding system without sacrificing seed or fiber yield.

Increasing seeding rate from 40 to 120 kg ha^{-1} did not increase seed yield at any location or seeding date. While fiber content was not affected by seeding rate, higher seeding rates increased stem numbers, decreased stem size and reduced the variability in stem size. Finer stems, with lower variation in stem size, are likely to result in more uniform retting and improved fiber quality. Fiber yield was increased by increasing seeding rate in the cool wet season of 2004 but had little impact in 2003, a dry season. These findings are similar to European research and would indicate that increasing seeding rates of oilseed flax cultivars will likely be necessary to optimize fiber yield and quality. Higher seeding rates tend to increase lodging potential and thus lodging prone cultivars should not be used; particularly in fields which are prone to lodging. The fiber cultivar Evelyn had nearly double the fiber yield of Flanders and Taurus but seed yields of Evelyn were approximately half the yield of the oilseed cultivars.

Fiber content and fiber yields increased at sites where moisture content was higher and total straw yields were greater. This may be due to the greater fiber content of low part of the stems and the greater height when crops are produced under better moisture conditions.

The impact of seeding date was erratic presumably due to the widely differing soil moisture levels between site years. Delaying seeding until the end of May increased fiber yields in this set of trials by an average of 35% without a corresponding drop in seed yield. This is in contrast to other work when delayed planting often reduced seed yield. Thus delayed planting may improve fiber yield by increasing total biomass but reduced seed yields may occur.

In excess of 20 cultivars representing both fiber and oilseed types were compared with hoe and sweep planting tools. There were no significant interactions in seed or fiber yield between hoe seeding and sweep seeding. The lack of interactions would indicate that it should be possible to select for fiber yield in standard breeding plots. This is an important factor because most plot drills can not plant in very narrow rows.

The fiber cultivar Hermes produced almost double the amount of fiber as the oilseed types. Lelystad and Natsja had intermediate fiber and seed yields. The greater height of Hermes and fiber similar cultivars will likely result in a greater tendency to lodge under good moisture and fertility conditions. Several cultivars had low fiber yields including: Normandy, Hala, Arras and Linola 2090. Widely grown oilseed types such as CDC Bethune and older cultivars such as Flanders and Norlin had good seed and fiber yields in both seasons and could be considered for fibre production. While we did conduct a heritability trial for flax fiber, 7 cultivars ranked in the top 10 in both seasons. Redwood 65, an older tall oilseed type, had higher fiber yields likely due to greater plant height since it had lower fiber content in the stem than many of the current oilseed cultivars. While there is significant variability within the oilseed cultivars the fiber yield is significantly lower than the fiber varieties. While it may be possible to develop higher fiber cultivars which have high seed yield, current oilseed cultivars do not meet this criteria. Improvement in fiber yield should be possible due to the introduction of near infrared fiber

analysis and the ability to use standard breeding plots for fiber, as well as seed determinations. Vimy is a lodging prone cultivar but has relatively higher fiber content and fiber yield indicating that selection for improved lodging tolerance is unlikely to indirect selection for higher fiber content. Superior lodging tolerance and tall cultivars may have potential when selecting for high fiber yield but direct measurement of the fiber content of the stem will likely be necessary unless marker systems can be found.

The development of a fibre industry based on production of oilseed flax with fiber as a by product will likely occur when superior genetics are identified and improved retting systems are developed so that the cost of fiber production reduced. As markets develop the value of the fibre may improve so that specialized management will be profitable. A higher fiber content cultivar, which has good lodging tolerance, planted at least 80 kg/ha would likely be an effective method of improving fiber yield and quality of oilseed flax. Under high moisture conditions narrow rows or sweeps may be warranted as a method of improving flax yields however the impact is not consistent or large. The trials conducted did not improve retting to any extent and further work would be desirable including determination of the impacts of fungicides on retting and the potential for selection for ease of retting.

Very little retting occurred in the fall of either growing season, thus, the various management systems tested to enhance retting had little value. Further work needs to be conducted to enhance retting and straw recovery so that spring harvest of straw can be avoided. Spring harvest of straw creates serious bottlenecks in terms of labor and seeding of the subsequent crop. It was not possible to develop a retting index based using the leaf wetness meter since retting did not occur due to cold weather after harvest or delayed harvest.

Objectives: To investigate the potential of existing seeding equipment for fiber production.

1. To identify a production system that will result in fiber suitable for mid to upper end uses at the least possible cost.
2. To determine the impact of flax straw management options on retting success in various climatic areas
3. To determine if varieties differ in relative fiber yields based on seeding system (full coverage of soil vs rows).

Materials and Methods

Trial 1 - Effect of seeding system and seeding rate on yield of flax fiber

Objective: To identify a production system which will result in fiber suitable for mid to upper end uses at the least possible cost.

This trial was planted at Redvers, Canora and Indian Head in a 3 replicate split plot design with seeding dates being the main plots and seeding rate*cultivars as a complete factorial. Plots were 3.048 x 9.144 m with a spacing of 0.305 m between the plots A control treatment was planted at 40 kg ha^{-1} with a hoe opener.

Seeding equipment was modified to produce a broad band of seed below the surface using existing plot drills modified to use sweeps and overall packing to enhance germination. This consisted of the use of a "Frock boot" and the appropriate level of air to provide a "solid' seeding as is possible with an air seeder. All planting was done by PAMI using the same equipment at each site. After planting sweep plots were with harrowed with coil packer or rolled with a pea roller to create rapid uniform emergence. Nitrogen and phosphorus were applied at seeding as a side band with hoe openers and with the sweep with 85%+ seed bed utilization with the sweeps.

Weed control was accomplished using Poast and Buctril M or Flax Max at labeled rates.

The oilseed cultivars with high fiber content were Flanders and Taurus while Evelyn was the fiber variety. All of these cultivars were planted at 40, 80 and 120 kg ha^{-1} with the sweeps and at 40 kg ha^{-1} with the hoe openers.

Data collection procedures

Plant counts (6 samples of 0.25 m^{-2} from each plot, taken in the fall just prior to harvest). These areas were marked and the plants pulled from these areas at harvest. These samples were wrapped in cardboard rolls and stored until analysis was done by Biolin Inc. Plant heights were measured from the ground level of the stem to the top of the average heights of all stems in the field. The samples which were pulled had the roots removed and the top of the plant was removed just below where the seed bolls started to branch off the stem. The cut samples were measured to give the cut straw length and salvaged straw estimate was made by weighing this sample. Salvaged straw mass was multiplied by the fiber content measured using NIR to determine the fiber yield in kg ha^{-1}.

All sub-samples were analyzed for bast fiber content using a NIR machine (FOSS 6500). This was done by taking the straw from each sub-sample and scanning and re-arranging it five times to create a five scan average for each sub-sample. Software then used a database of historical scans to convert, as precisely as possible, the new sub-sample scans to bast fiber content readings.

Selected sub-samples were also processed using a manual method to extract bast fiber. This involved warm water retting of some of the previously NIR scanned sub-samples for four to six days until the results of the "Fried Shake Test" showed that the majority of bundles were optimally retted. In the "Fried Shake Test" fifteen pieces of retting straw, each approximately 10.0 cm in length, each from a different bundle, were placed in fifteen test tubes half full of boiling water with one piece of straw in each test tube. The test tubes were stoppered and placed in a machine designed by Biolin Research to violently shake test tubes for 15 seconds. After shaking, the straw in each test tube was visually scored for loose fibers on a whole number scale from "0" to "3" with "0" representing no loose fibers and "3" representing total loosening of all bast fibers on the stem. When the average score was above 2.8 and there were no "0" scores and at least twelve test tubes had a score of "3", the bundles in the batch were considered fully retted. The bundles were then taken out of the tank, rinsed in tap water and set in drying racks, next to heater fans, for approximately four days to dry. Dry bundles from these selected retted samples were weighed and the fiber was extracted using a reciprocating blade-type breaker/decorticator. The fiber was hand cleaned to the point where few or no shives were left. After cleaning, the fiber was weighed and placed in separate sample bags and labeled with a catalog number. The bast fiber content was then expressed as a percent of the unretted stems by taking the weight of the extracted clean, retted fiber and dividing by the original weight of the unretted stems in the sub-sample in question and multiplying by 100. The resulting data was then compared with the original data from NIR analysis.

Stem size was determined 100 stems from each plot using a digital caliper.

Seed yield by harvesting a single strip from each plot with a 1.5 m width of a small plot combine.

Data analysis

Due to heterogeneous variances each site was analyzed separating using SAS PROC GLM. The seed yields at Indian Head in 2004 were extremely variable and due to in season flooding and while presented should not be considered viable data.

Trial 2 Field retting from various straw management options

Objective: To determine the impact of flax straw management options on retting success in various climatic areas.

Materials and Methods

This trial was planted at Redvers, Canora, and Indian Head in 2003 and 2004. Taurus flax was planted at 80 kg ha^{-1} using sweeps with Frock boots to obtain a wide scatter of seed. All seed and fertilizer were applied at the time of planting according the recommended practice for the area. Due to the fact that there was 85% plus seedbed utilization fertilizer was applied with the seed.

Touchdown IQ was applied prior to harvest (75% brown bolls) at 1.0 L ac^{-1}. Previous work has shown an increase in retting from this formulation of preharvest glyphosate application.

Harvesting treatments were single passes of the various management options operated at right angles to direction of planting. The test design was a Randomized complete block with 4 reps. All plots have an initial and final fiber yield. Retting was measured with the Fried hot water test by technical staff at Biolin Research Inc. Flax stems (8.9 cm in length) are shaken for 40 seconds and the degree of fiber separation noted. In the "Fried Shake Test" fifteen pieces of retting straw, each approximately 10.0 cm in length, each from a different bundle, were placed in fifteen test tubes half full of boiling water with one piece of straw in each test tube. The test tubes were stoppered and placed in a machine designed by Biolin Research to violently shake test tubes for 15 seconds. After shaking, the straw in each test tube was visually scored for loose fibers on a whole number scale from "0" to "3" with "0" representing no loose fibers and "3" representing total loosening of all bast fibers on the stem. When the average score was above 2.8 and there were no "0" scores and at least twelve test tubes had a score of "3", the bundles in the batch were considered fully retted.

The following harvest treatments were applied at right angles to the direction of seeding

1. Harvest (combine) the crop as low as possible to the soil and then roll the field with a pea roller or to press the straw to the ground.
2. Harvest (combine) the crop as low as possible to the soil and do not press into the soil (use the same harvest equipment as in #1).
3. Strip the seed or simply cut as low as possible to the soil with a sickle bar mower and roll to ensure contact with the soil If you can not strip the seed strip the bolls at time of sampling
4. Strip the seed and then cut with a disc mower and roll or simply cut with a disc mower and then roll (a sickle bar haybine can be used by set as close to the soil as possible 2-4 cm).

Data on field retting

Temperature and moisture were monitored using the leaf wetness sensors from Spectrum. The plan was to collect 0.25 m^{-2} samples based on leafwetness*temperature intervals base 10 °C. Wetness interval of 30 where leaf wetness (#hours wet/24)*(#hours >10 C /24). However, there was a lack of retting in the fall of 2003 and thus samples were taken in the spring of 2004. The freeze thaw cycle has been observed to enhance over winter retting of samples. Sampling of this trial will occurred in the spring of 2005 for the 2004 growing season.

Data Analysis

There were varying numbers of sample dates at each location and thus analysis across sites is not possible. The data was analyzed using regression methods with binary variables to determine if there are statistically significant relationships between yields, varieties, treatments and locations. The reader should note that the most common statistical method used to analyze data from agronomic trials is Analysis of Variance. In general, when analysis of variance is used, it only shows if a particular result is significantly different from other results. Regression analysis is another statistical tool that can be used to pinpoint significant differences in the results of agronomic trials.

Trial 3 Effect of seeding method and cultivar on fiber content of Linseed and Solin cultivars

Objective: To determine if cultivars differ in relative fiber yields based on seeding system (full coverage of soil vs rows planted with a hoe opener)

Materials and Methods

Flax was planted in a 3 replicate split plot design at Canora, Redvers and Indian Head. Main plots were variety and each subplot had "4 rows" on 30 cm spacing with 0.3 m between the plots. The subplot treatments were hoe seeding and sweep "solid" seeding. Sweep seeding was accomplished by modifying a 4 row hoe drill by the addition of a sweep with a "Frock" boot and an air delivery system. The air delivery system consisted of Valmar venturie with air being supplied using a leaf blower. This system is low cost highly portable and the air flow is easily adjustable. Twenty one varieties were planted in 2003 and twenty five cultivars in 2004 using a constant seeding rate of 80 kg ha^{-1}. Nitrogen was broadcast at soil test levels and phosphorus broadcast at 4 x soil test recommended levels after seeding. Preharvest Touchdown applied at 1.0 L ac^{-1} when 75% of the bolls on latest variety were brown.

At Canora, in 2003, the plots were harvested for seed with a small plot combine as tall as possible while collecting all the seed. At Canora snow came prior to harvest of samples for fiber in 2003 and samples were taken in the spring of 2004. In 2004 the entire plot was cut with a forage harvester to determine biomass and then this material was threshed to determine seed yield. Samples for fiber were taken by pulling the sample area prior to harvest in order to ensure an adequate sample length.

Except for Canora in 2003, samples for fiber analysis were pulled from 0.25 m^{-2} area prior to harvest of the seed and sent to Biolin for analysis.

Data Analysis

Analysis of variance was conducted on all variables on an individual site basis. A summary of mean yields and quality is presented across sites each year but not subjected to analysis of variance due to the heterogeneity of variances. In addition yields were expressed as a percentage of the mean of the field.

Results and Discussion

Trial 1 Impact of seeding rate on yield of flax fiber

Increasing seeding rate from 40 to 120 kg ha^{-1} did not increase seed yield at any location (Table 3 and 4). While there was a significant interaction between cultivar and seed rate at Indian Head in 2004 this trial had highly variable seed yields due to flooding during the cropping season. Evelyn the fiber variety had lower seed yields at 5 of the 6 sites with the Indian Head site being the only site where this was not significant (Tables 5-10). In 2003 all sites had seeding date by cultivar interactions while this did not occur in 2004 (Tables 3-4).

Seeding rate increased the number of stems at all sites and as number of stems increased, stem diameter decreased (Tables 3-10). There was a significant cultivar impact on stem numbers in both seasons but in 2003 Flanders had the highest plant numbers but the lowest at all sites in 2004. This did not appear to be related to cultivar per se but likely due to seed source. There was a significant interaction between seeding date and seeding rate in the number of stems at all locations in 2003 and at all sites except Indian Head in 2004. This interaction is likely due to moisture and temperature differences between the seeding dates.

As seeding rate, and hence stem numbers, increased the size of the stems decreased in the order of 20-35% (Tables 3-10). Smaller stems are generally considered to be easier to ret and have superior fiber quality but depending on the end use the increased cost of these high seeding rates may not be warranted. There was a small but significant reduction in stem size variation as seeding rates increased at half of the sites but once again value of this will have to be determined under commercial extraction systems. Smaller stems may be more susceptible to lodging but no significant levels of lodging occurred in these trials.

Fiber content was not affected by seeding rate at any of the six sites (Tables 3-4). Thus differences in fiber yield were due to the amount of straw which was available for salvage. In 2003 there were no significant differences in the amount of salvaged straw resulting from seeding rate. However, in 2004 the amount of salvageable straw and hence fiber yield increased 20, 28, and 34% at Canora, Indian Head and Redvers respectively. Thus in seasons with adequate moisture, such as 2004, there is value to higher seeding rates to increase fiber yield. This advantage occurred equally for all cultivars but the fiber yield of Evelyn was 80-120% greater than Flanders and Taurus.

At the sites where there were differences due to seeding date, late seeding increased seed and fiber yield in 2003 and reduced fiber yields in 2004 at Indian Head (Tables 3-4). However, differences due to seeding date were less than that due to location and the location effects were likely related to moisture levels since Canora had more precipitation than Redvers which was wetter than Indian Head.

Interaction of seeding method, cultivar and seeding date.

Seed yields did not differ significantly due to seeding tool at any site in either year but the arithmetic mean of the percent yield was 6% greater for sweep seeded plots (Tables 1, 2). This is similar to the results of Stevenson and Wright (1996) and Alessi and Power (1970) who found a 9% yield improvement when flax was planted on 7.5 cm vs 15 cm or wider row spacing. The sweeps are not exactly equivalent to narrow row spacings but do spread out the plants over a larger area and as a result create the potential for more light interception early in the growing season. The small and non significant impact of sweep planting in this trial differs from the result in trial 3 where seed yields were increased by the use of the Sweep seeder. Trial three had shorter plots which may have be subject to greater edge effects.

There were no significant interactions between seeding method, seeding date and cultivar in any site year for seed yield (Tables 1 and 2). The fiber cultivar Evelyn had lower seed yields than Flanders or Taurus at all locations and in both years (Tables 11-16).

The Redvers site in 2004, was the only site year where the number of stems was significantly impacted by seeding method and in this case the hoe seeding had slightly greater number of stems than the sweep (Tables 2 and 16). Stem diameter was not affected by seeding method at any site (Table 1-2). Likewise variability in stem diameter, as indicated by the standard deviation of the stem diameter, was not affected by seeding method at any site in either season (Tables 1-2).

There was a significant impact of seeding tool on fiber content at Indian Head in 2003 and Redvers in 2004 (Tables 1-2, 12,16) with sweeps resulting in slightly higher fiber contents. When all sites were considered sweep seeding have fiber yields ranging from 12% less to 16% more than the hoe openers (Tables 11-16). Thus there is no clear advantage to using sweeps to plant flax for fiber either in terms of fiber yield or stem quality. However, since there was a clear advantage to higher seeding rates it may be necessary to use sweeps or narrower row spacing to allow more plants to establish. Narrow row spacings are difficult to obtain under direct seeding conditions unless 2 drills are slightly offset and pulled in tandem or sweeps are used to spread the seed as in this case.

While there were several significant impacts of seeding date and its interaction with seeding tool these interactions were not found at all sites and as such are of limited interest at this time.

Impact of seeding date on seed and fiber yields

There was no clear impact of seeding date on seed yield except under conditions such as 2004 at Indian Head where an early frost significantly reduced late seeded crop in 2003 at Canora where drought had the same impact (Table 3,4) . Fiber yield was significantly higher from late seeding at Canora in 2003 and at all sites in 2004 (Table 3,4). In every case late seeding had higher fiber yields ranging from 20 to 50% higher with an average of 35% more fiber yield. A nine year study at Minot North Dakota found that early maturing cultivars such as Norlin preformed better at late seeding dates (Thompson et al 1988). Crops planted in the first week of June yielded 21% less than crops planted in the first week of May. In a recent unpublished trial conducted at Indian Head, Brandon, Morden and Melfort the impact of seeding date on flax seed yield was not as clear. The shortest crops were obtained from early planting. Thus there would seem to be some trade off between seed yield and fiber yield with later seeding resulting in improved fiber yields at the expense of seed yield in some seasons. There may be the potential to breed for better seed yields from delayed planting of flax as flax is commonly planted in the later part of May. There has been a consistent effort to test all potential flax cultivars at a late planting date.

Trial 2 Field retting from various straw management options

There was no significant amount of retting in the fall of 2003 or 2004 at any site (Tables 28-30). The major problem in 2003 was extremely dry weather during the fall and in 2004 a very cold summer delayed flax maturity such that there was very little retting potential (Table 31). The spring of 2005 was more normal in terms of temperature and moisture and as a result retting occurred in the season. In The use a leaf wetness* temperature index could not be fully tested at any site since there was no fall retting. Further work on this index is being conducted at Brandon Manitoba since there is a higher amount of dew present at this location. There was little retting in the spring of 2003 at either Indian Head or Redvers but at Canora retting in the spring was significant (Table 28). Differences in fall straw management had little impact on the rate of retting in the fall or spring. All of the treatments spread the straw across a significant area of the plot and it appears that the weight of the snow resulted in most of the straw have good contact with the soil. It would appear that a stripper header to remove the flax bolls followed by rolling would be an excellent means to optimizing the amount of straw collected if followed by raking and baling in the spring. The use of a stripper header would retain all of the stubble including the top and the base of the stems.

The physical operation of combine harvest using a conventional combine had relatively little impact on the rate of retting (HTRT 1). Rolling the straw did not improve the retting where or not the material was combine harvested. It is likely that in more moist location where temperatures are higher after harvest rolling may be an advantage since it mimics the pulling operations conducted for production of linen in northern Europe. Cutting flax stubble within 5-7 cm of the soil surface, spreading the straw and then raking will require significant extra cost relative to simply baling the straw from the windrow remaining after combine harvest. Evaluation of spreading and raking vs windrowing should be done using commercial harvesting equipment over a number of sites and years with careful measurements of weather and fiber yields being taken.

Evaluation of differing combine types has not been done at this time but should be considered since it is well known that rotary threshing combines are more aggressive in their straw management. Likewise stripper heading of flax following by aggressive cutting and conditioning with newer forage maceration equipment may improve the rate of retting but could have negative impacts on baling and fiber quality. This type of hay maceration equipment breaks open the straw resulting in more rapid initially drying rate but the with a higher potential to rewet. Since the straw is already mature and dry after harvest damaging the straw may be advantageous. However, these statements are speculative since very little retting occurred in the fall and the weight of wet snow will negate almost all impacts of fall straw management providing the straw is spread.

The fibre content of the flax straw improved dramatically from fall 2003 to early spring 2004 at Canora and at Indian Head and Redvers 2004 from the fall of 2004 to the spring of 2005 (Tables 28-30). This corresponded to the increase in the Fried test numbers from less than 0.5 in the fall to nearly 1.5-2.4 in the early spring. The "increase" in fibre content is almost certainly the result of the loss of mass other than fiber and would have a positive impact of the processing costs. This major change occurred prior to there being a significant amount of heat and may be physical weathering. If there were sufficient time and labor to bale the flax straw in the spring this may have a significant positive economic impact relative to fall harvest. It is not known retting is also

improved in windrows or it the material needs to be pressed into the soil as with traditional long line flax processing.

All of these forms of management preclude the use of traditional long line flax straw processing which requires all of the stems to be parallel to each other. However, any of these forms of straw management are relatively easy to accomplish and would result in a large amount of straw available for use with limited extra effort. In the years of this trial it appears that in the major flax growing areas of Saskatchewan there is limited potential for retting in the fall and thus retting would likely happen in the spring of the following growing season. This creates serious concerns with labor and interferes with planting of the subsequent crop. Given these problems chemical or mechanical retting may have to be considered as viable alternatives. Physical retting may be more likely in the Red River valley of Manitoba or under irrigated conditions in Saskatchewan where fall conditions are warmer and more moist. Also since crops such as dry bean are planted later in May retaining flax in the field until Mid May would not delay seeding due would cause serious problems with labor. Continued efforts need to be made to harvest retted straw in the fall to limit labor conflicts.

Trial 3 Effect if seeding method and variety on fiber content of Linseed and Solin cultivars

Averaged over the six site years of data in this trial plots planted with sweeps had 24% greater seed yield than when planted with a hoe opener (Tables 17-23). Flax planted with sweeps yielded 2, 8 and 23% more seed than the hoe planted plots at the Indian Head, Redvers and Canora sites respectively in 2003 and 28, 60 and 19% greater at these sites in 2004. This is in contrast to previous research where Lafond found no difference in seed yield from 10 to 30 cm spacings under direct seeded conditions at Indian Head but is in line with However, there was no instance where there was a significant crossover in yield indicating that in general crop yield was similar under both seeding systems. Since very few sweep seeding systems exist for plot work the ability to obtain accurate responses in relative cultivar yields is important to crop breeders.

Although narrow row spacing is used in Europe to maximize yields of fiber this was not the result of these trials where salvageable straw yields, fiber content and thus fiber yield were very similar with both seeding systems (Tables 17-23)

Hermes produced almost double the amount of fiber as the oilseed types (Tables 17-23). Lelystad and Natsja had intermediate fiber and seed yields. The greater height of Hermes and similar cultivars will likely result in a greater tendency to lodge under good moisture and fertility conditions. Lodging did not occur at any site in 2003 due to dry conditions during seed filling and there was lodging only at Canora in 2004. Several cultivars had low fiber yields including: Normandy, Hala, Arras and Linola 2090 (Tables 26-27). Cultivars such as Mons and Valor varied between seasons. Widely grown oilseed types such as CDC Bethune and older cultivars such as Flanders and Norlin had good seed and fiber yields in both seasons. Redwood 65, an older tall oilseed type, had higher fiber yields due to greater plant height and had lower fiber content in the stem than many of the current oilseed cultivars. While there is significant variability within the oilseed cultivars the fiber yield is significantly lower than the fiber varieties. While it is possible to have higher fiber cultivars which have high seed yield it seems unlikely that the current oilseed cultivars meet this criteria and breeding for greater height may be required. There does not seem to be any relationship between fiber content and current lodging ratings with Vimy having good fiber content and poor lodging tolerance. Thus selecting for lodging tolerance is unlikely to result in selection for high fibre yield.

There was a significant interaction between cultivar and seeding tool at Redvers in 2003 for fiber yield and the probability of a significant interaction at Indian Head was 0.08 while in 2004 there were no significant interactions between cultivar and seeding tool. Cultivar crossovers between sweep and hoe planted plots for fiber and seed yield were relatively few and of limited biological impact indicates that it is possible to select higher fiber content cultivars from existing breeding trials.

The following selection system might have potential for selecting for high fiber yield in flax. Determine plant biomass after flowering using an active sensor for net vegetation index, followed by fiber determination using NIR techniques. During the initial phases of development of the NVDI calibrations it will be necessary to determine actual fiber yields in the field by use of a combine harvester equipped with a weigh bucket to collect and weigh straw or a weighing system which picks up the straw and determines mass in a separate operation. Both of these increase the work load in the breeding operation significantly.

References

Alessi, J. and Power, J. F. 1970. Influence of row spacing, irrigation and weeds on dryland flax yield, quality and water use. Agron. J.62:635-637.

Easson, D.L. and Molloy, R.M. 2000. A study of the plant, fibre an seed development in flax and linseed (*Linum usitatissium)* grown at a range of seed rates. J. of Agric. Sci. Cambridge 135:361-369.

Stevenson, F.C. and Wright A.T.. 1996. Seeding rate and row spacing affect flax yields and weed interference. Can. J. Plant Sci. 76:537-544.

Thompson, C. R., Hoag, B. K. and Lukach, J. R. 1988. Flax variety response to planting date. North Dakota Farm Research. 45(5):22-26.

Table 1. Factors showing significant differences in Trial 1 hoe vs Sweep 2003								
	site/yr	seeddate	cult	tool	sd*cult	cult*tool	sd*tool	sd*cult*tool
seed yield kg ha^{-1}	Inhd03		*					
	Can03		*					
	Redv03		*					
straw yield kg ha^{-1}	Inhd03	*	*		*		*	
	Can03							
	Redv03	*	*					
salvaged straw kg ha^{-1}	Inhd03	*	*					
	Can03			*	*			
	Redv03							
number stems	Inhd03		*					
	Can03		*		*			*
	Redv03	*	*		*		*	
stem diameter	Inhd03		*					
	Can03	*	*					
	Redv03		*					
stem diameter std	Inhd03							
	Can03		*					
	Redv03		*					
Fiber %	Inhd03		*	*				
	Can03		*		*			
	Redv03	*	*					
Fiber yield kg ha^{-1}	Inhd03	*	*		*			
	Can03		*	*	*			
	Redv03	*	*		*		*	

Inhd= Indian Head Can=Canora Redv=Redvers

sd=seeding date tool=seeding tool sweep vs hoe cult=cultivar

Table 2. Factors showing significant differences in Trial 1 hoe vs Sweep 2004

	site/yr	seeddate	cult	tool	sd*cult	cult*tool	sd*tool	sd*cult*tool
	Inhd04	**	*		*			
	Can04		**					
seed yield kg ha^{-1}	Redv04		**					
	Inhd04							
	Can04							
straw yield kg ha^{-1}	Redv04							
	Inhd04	*	**	*				
	Can04		**					
salvaged straw	Redv04	*	**		*			
	Inhd04	*	**				**	
	Can04		**					
number stems	Redv04		**	**				
	Inhd04	*	**				*	
	Can04		**			*	*	
stem diameter	Redv04	*	**					
	Inhd04	*	**				*	
	Can04							
stem diameter std	Redv04							
	Inhd04		**			*		
	Can04		**				*	
Fiber %	Redv04		**	*			**	**
	Inhd04		**	*		*		
	Can04	*	**					
Fiber yield kg ha^{-1}	Redv04	*	**		**		*	

Inhd= Indian Head Can=Canora Redv=Redvers

sd=seeding date tool=seeding tool sweep vs hoe cult=cultivar

Table 3. Factors showing significance trial 1 comparison of seeding rate*cultivar*seeding date 2003								
		seeddate	srate	cult	cult*srate	sd*srate	sd*cult	sd*cult*srate
seed yield kg ha^{-1}	Inhd03			*			*	
	Can03			*			*	
	Redv03	*		*			*	
straw yield kg ha^{-1}	Inhd03	*		*				
	Can03						*	
	Redv03	*		*				
salvaged straw kg ha^{-1}	Inhd03			*				*
	Can03			*			*	
	Redv03	*		*			*	
number stems	Inhd03		*	*		*	*	
	Can03		*	*		*	*	
	Redv03	*	*	*		*	*	
stem diameter	Inhd03		*	*				
	Can03		*	*				
	Redv03		*	*				*
stem diameter std	Inhd03		*	*				
	Can03							
	Redv03		*	*				
Fiber %	Inhd03			**				
	Can03			**				
	Redv03	*		**				
Fiber yield kg ha^{-1}	Inhd03			**				*
	Can03			**			*	
	Redv03	*		**		*		

Inhd= Indian Head Can=Canora Redv=Redvers
sd=seeding date srate=seeding rate cult=cultivar

Table 1

Table 4. Factors showing significance trial 1 comparison of seeding rate*cultivar*seeding date 2004								
		seeddate	srate	cult	cult*srate	sd*srate	sd*cult	sd*cult*srate
seed yield kg ha^{-1}	Inhd04	*			*			
	Can04			**				
	Redv04			*				
straw yield kg ha^{-1}	Inhd04							
	Can04							
	Redv04							
salvaged straw	Inhd04	*	**	**	*			
	Can04	*	**	**				
	Redv04	**	**	**				
number stems	Inhd04		**	**				
	Can04	*	**	**	**	*		
	Redv04	*	**	**	**	**		
stem diameter	Inhd04	*	**	**				
	Can04		**	**				
	Redv04	*	**	*				
stem diameter std	Inhd04		*	**				
	Can04							
	Redv04	*		**				
Fiber %	Inhd04			**			*	
	Can04			**				
	Redv04			**		**		
Fiber yield kg ha^{-1}	Inhd04	*	**	**			**	
	Can04	**	*	**				
	Redv04	**	**	**			**	

Inhd= Indian Head Can=Canora Redv=Redvers
sd=seeding date srate=seeding rate cult=cultivar

Table 5 Impact of seeding rate on seed and fiber yield Canora 2003

seeding date	Cultivar	seeding rate kg ha^{-1}	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Salvageable straw kg ha^{-1}	Number of stems m^{-2}	Stem diameter mm	stem diameter std	Fiber %	Fiber yield kg ha^{-1}
	Evelyn	40	773	5080	1754	447	1.68	0.57	20.2	530
	Evelyn	80	852	5605	2030	631	1.34	0.48	19.8	619
	Evelyn	120	868	5795	2133	686	1.31	0.48	21.3	676
	Flanders	40	1719	6355	1564	674	1.42	0.45	18.1	436
	Flanders	80	1650	6000	1624	748	1.22	0.47	19.0	482
	Flanders	120	1695	6160	1633	995	1.18	0.41	17.2	449
	Taurus	40	1520	6245	1677	465	1.51	0.49	15.8	395
	Taurus	80	1482	5865	1694	609	1.33	0.50	16.2	412
	Taurus	120	1746	5640	1560	776	1.38	0.45	15.6	376
lsd sr*cult			119	1150	81	131	0.19	0.03	3.7	201
		40	1337	5893	1665	529	1.54	0.50	18.0	454
		80	1328	5823	1782	663	1.29	0.48	18.3	504
		120	1436	5865	1775	819	1.29	0.44	18.0	500
lsd seedrate			158	664	47	75	0.11	0.02	2.1	116
	Evelyn		831	5493	1972	588	1.44	0.51	20.4	608
	Flanders		1688	6172	1607	806	1.27	0.44	18.1	456
	Taurus		1582	5917	1644	617	1.41	0.48	15.8	394
lsd cult			158	664	47	75.4	0.11	0.02	2.1	116
early			1471	5830	1604	701	1.28	0.45	17.0	419
late			1263	5890	1878	639	1.46	0.50	19.2	553
cv			17.3	16.7	26.6	17	12.00	18.50	17.5	25

Table 6 Impact of seeding rate on seed and fiber yield Indian Head 2003

seeding date	Cultivar	seeding rate kg ha^{-1}	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Salvageable straw kg ha^{-1}	Number of stems m^{-2}	Stem diameter mm	stem diameter std	Fiber %	Fiber yield kg ha^{-1}
	Evelyn	40	376	3030	1190	243	1.41	0.54	18.7	221
	Evelyn	80	343	3040	1300	329	1.45	0.48	17.6	230
	Evelyn	120	319	3240	1480	519	1.14	0.45	17.1	253
	Flanders	40	864	3570	660	244	1.29	0.47	13.4	89
	Flanders	80	904	2950	670	363	1.11	0.39	13.2	88
	Flanders	120	786	2720	650	394	1.02	0.39	13.6	89
	Taurus	40	867	3410	680	250	1.26	0.45	13.8	94
	Taurus	80	877	3290	730	337	1.10	0.40	13.8	100
	Taurus	120	841	2880	700	385	1.13	0.40	13.7	95
LSD C*SR			93	500	230	121	0.15	0.07	1.5	47
		40	708	3582	982	272	1.35	0.49	15.6	159
		80	706	3370	1017	389	1.25	0.43	15.2	161
		120	681	3245	977	540	1.11	0.43	15.7	156
LSD			93	289	133	70	0.09	0.04	0.9	27
	Evelyn		387	3203	1335	393	1.38	0.50	18.1	241
	Flanders		874	3377	793	435	1.13	0.43	14.2	114
	Taurus		833	3617	847	373	1.21	0.41	14.2	121
LSD			93	289	133	70	0.09	0.04	0.9	27
early			686	3130	900	341	1.21	0.44	15.0	140
late			710	3670	1090	460	1.26	0.45	16.0	177
CV			11.4	12.6	19.7	17	10.44	13	8.5	25.2

Table 7. Impact of seeding rate on seed and fiber yield Redvers 2003

Seeding date	cultivar	seeding rate kg ha^{-1}	seed yield kg ha^{-1}	straw yield kg ha^{-1}	Salvageable straw kg ha^{-1}	Number of stems m^{-2}	Stem diameter mm	stem diameter std	Fiber %	Fiber yield kg ha^{-1}
	Evelyn	40	498	3845	1174	225	1.85	0.55	21.4	383
	Evelyn	80	603	4230	1300	297	1.60	0.49	21.6	425
	Evelyn	120	650	4450	1314	419	1.50	0.47	21.1	422
	Flanders	40	1423	4585	854	300	1.51	0.44	17.3	224
	Flanders	80	1510	4765	853	430	1.26	0.35	17.4	226
	Flanders	120	1475	4760	994	589	1.25	0.43	17.4	268
	Taurus	40	1504	4775	790	251	1.69	0.58	15.6	187
	Taurus	80	1453	5040	947	329	1.44	0.45	16.3	233
	Taurus	120	1443	4800	720	486	1.31	0.38	15.8	172
lsd sr*cult			157	516	335	90	0.15	0.10	1.2	77
		40	1142	4402	939	259	1.68	0.52	18.1	265
		80	1189	4678	1033	352	1.43	0.43	18.4	294
		120	1189	4670	1009	498	1.35	0.42	18.1	287
lsd seedrate			54	589	133	52	0.09	0.04	0.9	27
	Evelyn		584	4175	1262	314	1.65	0.50	21.3	410
	Flanders		1470	4703	900	440	1.34	0.40	17.4	239
	Taurus		1467	4872	819	355	1.48	0.47	15.9	197
lsd cult			54	589	133	52	0.09	0.04	0.9	27
early			1093	4110	766	258	1.47	0.48	17.3	203
late			1254	5050	1221	481	1.51	0.43	19.1	361
cv			11.4	9.5	18.9	21	8.50	19.20	6.7	23

Table 8. Impact of seeding rate and seeding date on seed and fibre yield 2004 at Canora

seed date	Cultivar	seed rate kg ha^{-1}	seed Yield Kg ha^{-1}	stems m^{-2}	height cm	stem diameter mm	Stem diameter std	Salvageable Straw Yield kg ha^{-1}	Fiber Content (%)	Fiber Yield kg ha^{-1}
	Evelyn	40	416	459		1.7	0.56	2997	26.4	790
	Evelyn	80	399	807		1.4	0.47	3203	27.1	874
	Evelyn	120	379	1085		1	0.47	3489	26.9	938
	Flanders	40	973	243		1.8	0.58	1604	20.9	336
	Flanders	80	757	259		1.7	0.52	1628	21.1	343
	Flanders	120	919	291		1.6	0.64	1671	21.1	353
	Taurus	40	740	349		1.6	0.51	1671	20.7	347
	Taurus	80	510	691		1.3	0.49	2026	21.0	425
	Taurus	120	544	905		1.1	0.59	1753	20.1	352
LSD SR*Cult			178	81		0.2	0.09	454	1.1	132
		40	665	402		1.7	0.53	2369	23.4	576
		80	582	653		1.5	0.47	2625	23.5	641
		120	606	925		1.3	0.53	2838	23.3	691
LSD Cult			103	47		0.1	0.05	262	0.7	76
	Evelyn		398	864		1.4	0.49	3625	27.7	1009
	Flanders		863	395		1.6	0.53	2056	21.5	444
	Taurus		591	722		1.4	0.51	2152	21.1	455
LSD rate			103	47		0.1	0.05	262	0.7	76
Early			626	565		1.5	0.54	2227	22.8	529
Late			608	754		1.4	0.48	2995	24.0	743
cv			24.6	18		11.8	15.50	15	4.1	18

Table 9. Impact of seeding rate and seeding date on seed and fibre yield 2004 at Indian Head

seed date	Cultivar	seed rate kg ha^{-1}	seed Yield kg ha^{-1}	stems m^{-2}	height cm	stem diameter mm	Stem diameter std	Salvageable Straw Yield kg ha^{-1}	Fiber Content (%)	Fiber Yield kg ha^{-1}
	Evelyn	40	1307	252	84	1.90	0.66	2891	22.6	652
	Evelyn	80	690	445	81	1.71	0.58	3307	23.1	766
	Evelyn	120	932	580	81	1.38	0.54	3303	23.1	764
	Flanders	40	555	174	60	1.69	0.56	1604	17.5	285
	Flanders	80	1290	388	59	1.42	0.48	1818	18.5	340
	Flanders	120	652	475	57	1.33	0.56	1922	18.4	354
	Taurus	40	573	316	62	1.63	0.52	1536	18.3	284
	Taurus	80	776	472	59	1.41	0.49	1910	18.2	354
	Taurus	120	684	733	59	1.16	0.42	2517	18.3	464
LSD SR*Cult			540	121	4	1.80	0.07	306	1.0	69
		40	1545	421	65	1.44	0.53	1902	20.2	401
		80	677	460	70	1.53	0.50	2684	20.3	577
		120	264	397	64	1.56	0.57	2349	18.8	443
LSD rate			311	70	2	0.11	0.04	177	0.6	40
	Evelyn		976	426	82	1.66	0.59	3167	22.9	727
	Flanders		832	346	59	1.48	0.53	1781	18.1	326
	Taurus		678	507	60	1.40	0.48	1988	18.3	367
LSD Cult			311	70	2	0.11	0.04	177	0.6	40
Early			1414	464	61	1.38	0.44	1785	19.3	357
Late			243	388	71	1.64	0.56	2838	20.3	590
cv			55.5	17	5.5	10.44	13.00	11.3	4.4	12

Table 10. Impact of seeding rate and seeding date on seed and fibre yield 2004 at Redvers

seed date / Cultivar	seed rate kg ha^{-1}	seed Yield Kg ha^{-1}	stems m^{-2}	height cm	stem diameter mm	stem diameter std	Salvageable Straw Yield kg ha^{-1}	Fiber Content (%)	Fiber Yield kg ha^{-1}
Evelyn	40	872	147	76	1.8	0.6	2762	25.8	720
Evelyn	80	881	280	74	1.5	0.5	3245	25.3	824
Evelyn	120	801	422	75	1.3	0.5	3796	25.8	977
Flanders	40	1179	95	57	1.5	0.5	1610	19.1	321
Flanders	80	1242	196	57	1.4	0.5	1728	20.0	351
Flanders	120	1296	265	56	1.3	0.4	1969	19.8	393
Taurus	40	984	156	59	1.5	0.5	1776	18.2	333
Taurus	80	1248	288	59	1.3	0.5	2231	18.7	420
Taurus	120	1187	434	58	1.1	0.5	2479	18.9	468
LSD rate*cult		234	30	3	0.2	0.1	365	1.3	90
	40	1011	132	64	1.6	0.5	2049	21.0	458
	80	1123	154	64	1.4	0.5	2401	21.3	531
	120	1094	172	63	1.2	0.5	2748	21.5	612
LSD rate		135	17	2	0.1	0.0	211	0.7	52
Evelyn		851	283	75	1.5	0.6	3268	25.6	840
Flanders		1239	273	72	1.4	0.5	1769	19.6	355
Taurus		1139	259	69	1.3	0.5	2162	18.6	407
LSD Cult		135	17	2	0.1	0.0	211	0.7	52
Early		1002	274	52	1.17	0.44	1643	20.6	358
Late		1150	233	75	1.63	0.56	3156	21.9	710
CV		19	10	4	14	12.00	13	5	14.4

Table 11. Impact of seeding tool on seed and Fiber yield Canora 2003

seeding date	cultivar	seeding tool	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Salvageable straw kg ha^{-1}	Number of stems m^{-2}	Stem diameter mm	stem diameter std	Fiber %	Fiber yield kg ha^{-1}
Early	Evelyn	Hoe	653	537	2398	431	1.57	0.57	21.6	519
Early	Evelyn	Sweeps	857	504	2612	453	1.63	0.52	21.7	567
Early	Flanders	Hoe	1778	606	1690	544	1.27	0.45	16.9	287
Early	Flanders	Sweeps	1624	558	1861	514	1.23	0.43	16.6	311
Early	Taurus	Hoe	1555	569	1831	502	1.29	0.42	14.2	264
Early	Taurus	Sweeps	1665	695	2799	511	1.42	0.46	15.3	422
Late	Evelyn	Hoe	487	594	2646	498	1.58	0.53	20.1	529
Late	Evelyn	Sweeps	688	512	2653	441	1.73	0.62	18.7	493
Late	Flanders	Hoe	1636	553	2332	507	1.43	0.48	18.7	436
Late	Flanders	Sweeps	1813	713	2827	835	1.61	0.47	19.6	561
Late	Taurus	Hoe	1044	506	1804	419	1.48	0.53	16.7	307
Late	Taurus	Sweeps	1374	554	2229	419	1.60	0.52	16.3	368
		Hoe	1192	561	2117	483	1.44	0.49	18.0	390
		Sweeps	1337	589	2497	529	1.54	0.50	18.0	453
CV			22.5	18.1	20.4	16.4	11.9	13.1	11.7	21.9

Table 12. Impact of seeding tool on seed and Fiber yield Indian Head 2003

seeding date	cultivar	seeding tool	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Salvageable straw kg ha^{-1}	Number of stems m^{-2}	Stem diameter mm	stem diameter std	Fiber %	Fiber yield kg ha^{-1}
Early	Evelyn	Hoe	424	3155	1188	241	1.47	.57	17.3	207
Early	Evelyn	Sweeps	375	3032	1187	243	1.41	.54	18.7	221
Early	Flanders	Hoe	909	3269	635	249	1.31	.61	13.1	83
Early	Flanders	Sweeps	864	3567	663	243	1.29	.47	13.4	89
Early	Taurus	Hoe	921	3505	684	218	1.34	.47	13.3	91
Early	Taurus	Sweeps	867	3410	680	250	1.26	.45	13.8	94
Late	Evelyn	Hoe	400	3443	1526	309	1.48	.55	19.7	301
Late	Evelyn	Sweeps	394	3427	1532	295	1.55	.56	18.7	287
Late	Flanders	Hoe	876	5123	1012	379	1.25	.55	12.9	130
Late	Flanders	Sweeps	900	4134	928	335	1.27	.46	14.8	139
Late	Taurus	Hoe	791	4420	935	298	1.45	.51	13.4	126
Late	Taurus	Sweeps	844	3917	902	264	1.33	.44	13.9	126
		Hoe	720	3819	997	282	1.39	0.54	15.0	156
		Sweeps	708	3581	982	271	1.35	0.49	15.5	159
CV			15.8	10.1	11.2	11.4	9.4	17.8	5.2	12.5

Table 13. Impact of seeding tool on seed and Fiber yield Redvers 2003

Seeding date	cultivar	seeding tool	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Salvageable straw kg ha^{-1}	Number of stems m^{-2}	Stem diameter mm	stem diameter std	Fiber %	Fiber yield kg ha^{-1}
Early	Evelyn	Hoe	397	2889	1128	139	1.77	0.72	20.1	225
Early	Evelyn	Sweeps	502	3421	1236	166	1.78	0.54	20.0	247
Early	Flanders	Hoe	1240	4483	894	228	1.34	0.57	16.3	145
Early	Flanders	Sweeps	1278	3952	961	214	1.53	0.49	16.1	154
Early	Taurus	Hoe	1214	4392	938	192	1.70	0.52	15.7	147
Early	Taurus	Sweeps	1461	4311	1028	208	1.65	0.61	14.0	146
Late	Evelyn	Hoe	541	4391	2462	279	1.88	0.52	24.1	593
Late	Evelyn	Sweeps	496	4260	2284	283	1.92	0.55	22.7	518
Late	Flanders	Hoe	1573	5447	1544	459	1.55	0.37	18.6	286
Late	Flanders	Sweeps	1569	5216	1600	386	1.48	0.38	18.4	294
Late	Taurus	Hoe	1394	5620	1686	353	1.58	0.45	16.9	284
Late	Taurus	Sweeps	1547	5147	1326	299	1.69	0.52	17.2	227
		Hoe	1015	4537	1442	275	1.64	0.53	18.6	280
		Sweeps	1186	4386	1406	259	1.68	0.51	18	264
CV			12.6	8.3	12.1	12.8	7.9	21.3	5.0	10.9

Table 14. Impact of seeding tool on flax seed and fiber at Indian head 2004

seeding date	Cultivar	Seeding tool	seed Yield kg ha^{-1}	Stems m^{-2}	height cm	stem diameter mm	stem diameter std	Salvageable Straw Yield kg ha^{-1}	Fiber Content (%)	Fiber Yield kg ha^{-1}
Early	Evelyn	Hoe	1533	395	71	1.7	0.6	2843	23.1	646
Early	Evelyn	Sweeps	2485	254	70	1.8	0.7	2084	22.5	469
Early	Flanders	Hoe	802	238	54	1.7	0.5	1485	16.3	240
Early	Flanders	Sweeps	1015	186	55	1.7	0.5	1152	16.8	195
Early	Taurus	Hoe	1480	419	53	1.3	0.4	1586	16.1	256
Early	Taurus	Sweeps	997	335	54	1.6	0.4	1255	17.4	218
Late	Evelyn	Hoe	83	271	89	2.1	0.7	3515	23.2	818
Late	Evelyn	Sweeps	129	250	81	2.0	0.6	3697	22.6	834
Late	Flanders	Hoe	188	134	65	2.0	0.7	2062	18.2	373
Late	Flanders	Sweeps	95	162	60	1.7	0.6	2056	18.2	374
Late	Taurus	Hoe	144	220	64	1.9	0.7	2526	16.8	426
Late	Taurus	Sweeps	149	297	62	1.7	0.6	1817	19.2	350
		Hoe	705	280	66	1.8	0.6	2336	19.0	460
		Sweeps	812	247	64	1.7	0.6	2010	19.5	407
			61.8	16.7	5.6	10.0	15.1	17.0	5.2	17.2

Table 15. Impact of seeding tool and flax seed and fiber at Canora 2004

seeding date	Cultivar	Seeding tool	seed Yield kg ha^{-1}	stems m^{-2}	height cm	stem diameter mm	stem diameter std	Salvageable Straw Yield kg ha^{-1}	Fiber Content (%)	Fiber Yield kg ha^{-1}
Early	Evelyn	Hoe	298	496	74	1.8	0.5	2801	26.8	749
Early	Evelyn	Sweeps	416	459	73	1.7	0.6	2997	26.4	790
Early	Flanders	Hoe	945	274	57	1.6	0.5	1630	20.8	339
Early	Flanders	Sweeps	973	243	56	1.8	0.6	1604	20.9	336
Early	Taurus	Hoe	783	495	54	1.4	0.4	1724	21.1	365
Early	Taurus	Sweeps	740	349	54	1.6	0.5	1671	20.7	347
Late	Evelyn	Hoe	378	517	80	1.9	0.5	3356	26.8	904
Late	Evelyn	Sweeps	381	496	81	1.5	0.5	3409	29.1	992
Late	Flanders	Hoe	702	269	63	2.0	0.5	1844	21.1	388
Late	Flanders	Sweeps	860	397	63	1.7	0.5	2372	22.2	528
Late	Taurus	Hoe	671	515	62	1.5	0.5	2355	20.9	492
Late	Taurus	Sweeps	618	467	62	1.7	0.5	2163	21.2	460
		Hoe	692	427	65	1.7	0.5	2285	22.9	539
		Sweeps	664	401	64	1.7	0.5	2369	23.4	575
CV			27.8	22.4	3.4	9.6	9.7	11.2	3.7	13.3

Table 16 Impact of seeding tool and flax seed and fiber at Redvers 2004

seeding date	Cultivar	Seeding tool	seed Yield kg ha^{-1}	stems m^{-2}	height cm	stem diameter mm	stem diameter std	Salvageable Straw Yield kg ha^{-1}	Fiber Content (%)	Fiber Yield kg ha^{-1}
Early	Evelyn	Hoe	688	197	66	1.5	0.5	1969	24.7	486
Early	Evelyn	Sweeps	807	161	63	1.6	0.6	1865	25.0	466
Early	Flanders	Hoe	1129	134	48	1.3	0.4	1084	18.6	201
Early	Flanders	Sweeps	1177	100	46	1.3	0.4	958	17.1	163
Early	Taurus	Hoe	1273	203	51	1.5	0.4	1439	17.9	258
Early	Taurus	Sweeps	950	157	48	1.3	0.4	1067	16.9	181
Late	Evelyn	Hoe	817	170	89	1.9	0.6	3564	26.0	930
Late	Evelyn	Sweeps	937	133	88	2.0	0.7	3658	26.6	973
Late	Flanders	Hoe	1192	119	66	1.7	0.6	1952	18.7	366
Late	Flanders	Sweeps	1180	89	68	1.6	0.5	2262	21.1	478
Late	Taurus	Hoe	1003	169	69	1.7	0.4	2457	16.7	410
Late	Taurus	Sweeps	1017	154	69	1.8	0.5	2484	19.5	485
		Hoe	1017	165	65	1.6	0.5	2078	20.4	442
		Sweeps	1011	132	64	1.6	0.5	2049	21.0	458
CV			16.8	15.3	2.9	11.9	12.9	14.1	3.6	17.2

Table 17 Impact of seeding tool and cultivar on flax seed and fiber at Indian Head 2003

Cultivar	seed yield kg ha^{-1}	straw yield kg ha^{-1}	straw yield kg ha^{-1}	Plant height cm	cut straw cm	salvageable straw kg ha^{-1}	fiber content % NIR	fiber yield kg ha^{-1}
Arras	1072	1340	562	31.3	24.5	656	13	85
Bethune	1109	1620	699	33.5	26	856	13.3	112
Carnduff	1193	1588	753	34.7	26.5	864	13.8	118
Flanders	1156	1520	691	33.7	25.3	848	15.4	131
Hala	1023	1148	453	29.5	23.5	636	12.5	79
Hanley	1067	1348	630	32.5	25	796	14.8	119
Hermes	635	2836	1244	44	37.2	1488	18.5	275
Lightning	1044	1472	827	36.5	29.5	920	12.8	117
Linola1084	1108	1556	678	35.7	28.7	816	16.7	135
Linola2047	1085	1564	743	33.7	27	928	13.1	120
Linola2090	1137	1344	642	31.2	24.8	708	15.1	107
Macbeth	1027	1696	791	36.7	28.8	1028	12.5	128
Mons	1109	1532	767	33.8	26.2	824	13.6	111
Norlin	1134	1476	767	34.3	27.3	844	14.2	118
Normandy	1001	1152	696	34.5	27.3	708	13.4	94
Nugget	1090	1528	662	32	24.7	896	14.3	128
Omega	1046	1544	715	33.8	25.8	884	13.9	119
Taurus	1129	1908	793	36	28.5	896	13.7	123
Valour	1116	1308	680	34.2	27	732	13.4	98
Vimy	1092	1528	761	34.3	26.8	968	13.4	130
Watson	1144	1236	650	34	27	832	14.7	121
LSD	**68**	**400**	**100**	**3.5**	**3.4**	**180**	**1.4**	**23**
Seeding tool								
Hoe	1059	**41.1**	723	**35.1**	**28.2**	**940**	13.9	**132**
Sweep	**1086**	35.6	725	33.4	25.9	784	**14.3**	112
	*	**	ns	**	**	**	*	**

Table 18. Impact of seeding tool and variety on flax seed and fiber at Redvers 2003

Variety	seed yield kg ha^{-1}	straw yield kg ha^{-1}	straw yield kg ha^{-1} combine	Plant height cm	cut straw cm	salvageable straw kg ha^{-1}	fiber content % NIR	fiber yield kg ha^{-1}
Arras	1161	4480	664	50.5	24.1	796	15.2	121
Bethune	1320	5480	887	56.7	29.7	1152	16.6	191
Carnduff	1157	4560	807	55	28.5	948	16.3	155
Flanders	1355	5600	828	47.3	25.2	1024	17.5	180
Hala	1020	3800	523	42.5	21.3	576	14.4	83
Hanley	1475	5640	817	47.5	26	1060	16.5	175
Hermes	**564**	**6080**	**1256**	**73.8**	**40.2**	**1968**	**24.2**	**475**
Lightning	1307	5720	822	54.7	27.7	1028	15	154
Linola1084	1314	4760	907	50.5	26.5	904	18.6	169
Linola2047	1298	6480	788	51.2	24.5	1056	15.7	166
Linola2090	1011	4120	720	46.2	22.6	764	16.6	126
Macbeth	1050	5320	819	54.7	25	1036	14.4	149
Mons	1326	6120	817	52.3	26.3	1136	15.3	172
Norlin	1244	5240	867	52.7	27.3	952	17.2	165
Normandy	932	4080	653	52.3	22.8	732	15.8	117
Nugget	1250	4920	815	52.2	28	1012	17.1	175
Omega	1139	4480	846	46.2	28.6	1028	16.7	172
Taurus	1413	5480	1061	53.3	29	1208	17.3	208
Valour	994	4240	612	52	25	788	15.4	121
Vimy	1096	5280	721	50.2	27.5	1024	16.4	168
Watson	1296	4760	689	47.8	23.3	800	16.3	131
LSD	**253**	**1440**	**158**	**7.4**	**5.1**	**228**	**1.4**	**44**
Seeding tool								
Hoe	1132	**0.133**	787	**53**	27.3	**1056**	16.4	176
Sweep	**1223**	0.121	**824**	50.8	26	944	**16.8**	**164**
significance	**	**	*	**	Ns	**	**	**

Table 20. Impact of seeding tool and cultivar on flax seed and fiber at Canora 2003

Cultivar	Plant height cm	seed yield kg ha^{-1}	Salvagable Straw kg ha^{-1}	fiber content % NIR	fiber yield kg ha^{-1}
Arras	55.1	1715	1427	33.1	471
Bethune	57.9	1611.6	1309	30.9	407
Carnduff	56.2	1668.6	1173	32:7	382
Flanders	51.3	1620.8	1244	35.4	443
Hala	48.8	1572.1	1251	33.2	416
Hanley	53.6	1520.3	1406	32.6	458
Hermes	**74.9**	**911.3**	**1299**	**46.2**	**603**
Lightning	56.0	1732.7	1453	31.2	452
Linola1084	56.4	1862.8	1608	38.9	623
Linola2090	51.7	1844.7	1207	31.7	386
Macbeth	56.1	1765	1354	33.3	453
Mons	51.5	1596.1	1581	30.6	484
Norlin	54.1	1557.4	1547	31.4	488
Normandy	56.4	1520.3	1701	36.9	632
Nugget	52.5	1925.9	1531	32.9	504
Omega	53.4	1503.8	1173	33.4	391
Taurus	54.8	1665.2	1259	35.1	442
Valour	52.7	1598.7	1403	33.8	481
Vimy	58	1906	1586	33.0	526
Watson	52.7	1497.1	1606	34.1	547
LSD	2.6	374.2	539	34.8	202
Seeding tool					
Hoe	54.8	1457	1401	34.1	481
Sweep	55.6	**1803**	1423	34.0	483
	ns	**	ns	ns	ns

Table 21. Impact of seeding tool and cultivar on flax seed and fiber at Canora 2004

Cultivar	Seeding tool	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Cut Straw Length cm	Salvageable straw kg ha^{-1}	Fiber %	Fiber yield kg ha^{-1}
Arras		1658	5180	42.6	1143	20.7	235
Bethune		1672	5950	43.8	1209	20.5	247
Carnduff		1232	6423	40.9	1221	19.3	236
Flanders		1682	5330	36.8	971	22.4	218
Hala		1441	4706	33.5	693	20.5	141
Hanley		1417	4636	40.1	987	22.2	219
Hermes		**820**	7136	**57.3**	**1638**	**27.2**	**442**
Lelystad		**1555**	7034	**49.8**	**1840**	**25.6**	**471**
Lightning		1020	5758	39.1	1241	19.9	249
Linola1084		1637	5720	45.8	1126	23.9	266
Linola2047		1311	5888	44.1	1154	20.7	239
Linola2090		1980	5623	39.4	1163	20.4	237
Macbeth		1656	5135	38.7	941	19.6	184
Mons		1340	5523	38.6	1119	19.8	221
Natsja		**1218**	7545	**57.3**	**1864**	**22.9**	**425**
Norlin		1627	5260	45.0	1182	21.9	257
Normandy		1557	5742	43.5	1201	20.7	246
Nugget		1362	6157	40.5	1150	21.7	249
Omega		1541	6231	40.5	1103	21.9	240
Redwood 65		568	5520	43.3	1393	20.8	293
Somme		1359	6012	40.8	1217	21.4	261
Taurus		1426	6560	41.4	1301	20.8	268
Valour		1033	4705	45.3	1347	20.8	284
Vimy		1241	5225	37.8	1072	21.1	227
Watson		1279	6051	41.4	1575	20.8	325
LSD		594	1268	6.8	572	1.5	127
	hoe	1264	5373	42.0	1187	21.5	257
	sweep	1507	6230	43.3	1281	21.5	278
		**	*	ns	*	ns	*

Table 22. Impact of seeding tool and cultivar on flax seed and fiber at Indian Head 2004

	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Cut Straw Length cm	Fiber Content %	Salvageable straw kg ha^{-1}	Fiber yield kg ha^{-1}
Arras	2286	2489	35	1830	14.2	264
Bethune	3092	2996	38	2293	14.9	343
Carnduff	1913	1756	37	1465	14.8	220
Flanders	3103	2415	36	1879	16.7	316
Hala	2048	1379	33	1503	13.7	211
Hanley	2972	2698	37	2003	16.5	332
Hermes	**1654**	**2789**	**49**	**3031**	**20.8**	**635**
Lelystad	**2544**	**2522**	**41**	**2158**	**20**	**433**
Lightning	1835	2913	40	2299	13.4	306
Linola1084	2888	2265	37	1818	17.9	329
Linola2047	2403	2203	38	1852	15.2	281
Linola2090	2022	1897	34	1497	15.4	233
Macbeth	2408	1751	37	2031	14	287
Mons	2561	2173	35	1751	14.8	264
Natsja	**2681**	**3020**	**45**	**2684**	**16.1**	**433**
Norlin	2337	2068	37	1723	17.1	289
Normandy	2046	2647	40	2055	14.4	297
Nugget	2696	2653	36	2057	16.2	333
Omega	1234	2358	35	2009	15.3	313
Redwood 65	2166	2968	39	2329	15.2	359
Somme	2455	2022	35	1476	14.7	217
Taurus	1581	2219	35	1777	14.9	268
Valour	2246	2016	37	1693	14.8	253
Vimy	3222	2233	37	1911	15.4	298
Watson	2244	2232	34	1729	15.8	276
LSD	**1080**	**724**	**5.2**	**508**	**2.5**	**98**
hoe	2057	2037	37	1913	15.0	298
sweep	2634	2658	38	1995	16.0	325
	**	**	ns	*	**	ns

Table 23. Impact of seeding tool and cultivar on flax seed and fiber at Redvers 2004

Cultivar	seeding tool	Seed yield kg ha^{-1}	straw yield kg ha^{-1}	Cut Straw Length cm	Salvageable straw kg ha^{-1}	Fiber %	Fiber yield kg ha^{-1}
Arras		1807	1799	28	1538	20.8	319
Bethune		1919	2016	30	1861	21.7	406
Carnduff		1515	1516	32	1748	19.5	342
Flanders		1624	1701	27	1451	22.0	319
Hala		1399	1420	28	1647	19.5	319
Hanley		1292	1671	31	1997	21.8	432
Hermes		**1039**	2762	**49**	**3172**	**25.0**	**780**
Lelystad		**981**	1478	**36**	**1932**	**25.0**	**478**
Lightning		2144	1981	32	1693	20.4	349
Linola1084		1330	1551	27	1652	22.8	378
Linola2047		1318	1549	31	1625	19.9	323
Linola2090		1764	1564	27	1443	18.9	271
Macbeth		1312	1599	35	2000	19.7	406
Mons		2225	2010	29	1428	18.7	268
Natsja		**1243**	2467	**42**	**2607**	**22.4**	**581**
Norlin		958	1436	29	1913	22.5	431
Normandy		1610	1859	36	1787	19.2	344
Nugget		1813	1815	27	1694	20.7	350
Omega		1685	1983	35	1531	20.9	321
Redwood 65		1222	1791	34	2269	19.2	431
Somme		1337	1603	26	1681	19.9	332
Taurus		1169	1630	31	1943	20.0	385
Valour		1371	1675	36	1742	21.5	384
Vimy		1425	1740	35	1721	21.1	365
Watson		1119	1470	29	1729	22.1	382
LSD cult		**752**	**381**	**3.5**	**481**	**2.7**	**108**
	hoe	1123	1447	31	1857	20.2	379
	Sweep	1807	2050	33	1807	21.8	397
		**	**	**	ns	**	ns

Table 24. Summary of 2003 fiber traits all sites trial 3						
	Salvaged Straw kg ha^{-1}		Fiber Content (%)		Fiber Yield Based On Salvaged Straw kg ha^{-1}	
	Hoe	Sweeps	Hoe	Sweeps	Hoe	Sweeps
Arras	809	643	13.7	14.5	113	94
Bethune	1084	923	14.6	15.3	160	143
Carnduff	991	819	15.2	14.9	151	123
Flanders	981	890	16.5	16.5	163	147
Hala	633	581	13.2	13.6	83	79
Hanley	1018	839	15.7	15.5	160	132
Hermes	1837	1619	20.7	22.0	382	368
Lightning	1055	895	13.3	14.5	141	130
Linola1084	999	722	17.4	17.9	174	130
Linola2047	1098	883	14.5	14.3	159	127
Linola2090	825	646	15.6	16.1	129	105
Macbeth	1054	1010	13.2	13.7	139	137
Mons	1032	928	14.0	14.8	146	138
Norlin	1001	794	15.3	16.1	155	128
Normandy	732	710	14.2	15.1	103	108
Nugget	1027	881	15.8	15.6	164	138
Omega	1057	855	15.1	15.5	160	132
Taurus	1043	1057	14.8	16.3	156	175
Valour	856	663	14.3	14.5	123	96
Vimy	1027	963	15.2	14.6	156	143
Watson	807	825	15.2	15.8	123	129
AVG	808	644	13.7	14.5	113	94

Table 25. Summary of fiber traits over all sites 2004

	Salvaged Straw kg ha^{-1}		Fiber Content (%)		Fiber Yield Based On Salvaged Straw kg ha^{-1}	
	Hoe	Sweeps	Hoe	Sweeps	Hoe	Sweeps
Arras	1344	1664	17.9	19.2	231	314
Bethune	1732	1844	18.4	19.6	307	357
Carnduff	1531	1425	17.4	18.3	267	264
Flanders	1282	1586	19.8	21.0	244	324
Hala	1453	1109	17.5	18.4	247	200
Hanley	1743	1583	19.7	20.6	338	318
Hermes	2435	2792	23.1	25.6	548	691
Lelystad	1893	2060	23.2	23.8	434	488
Lightning	1783	1706	17.5	18.2	306	297
Linola1084	1478	1586	21.3	21.8	312	336
Linola2047	1573	1515	18.2	19.0	279	283
Linola2090	1354	1381	17.9	18.5	239	255
Macbeth	1559	1741	17.5	18.1	264	307
Mons	1416	1462	16.7	18.8	231	275
Natsja	2450	2320	20.7	20.2	492	467
Norlin	1587	1637	20.5	20.5	321	337
Normandy	1595	1767	17.9	18.3	280	311
Nugget	1606	1661	19.4	19.7	300	322
Omega	1528	1654	19.7	19.1	286	309
Redwood 65	1854	2140	17.9	18.9	321	400
Somme	1455	1461	18.2	19.1	264	276
Taurus	1659	1688	18.0	19.1	297	318
Valour	1633	1581	18.9	19.2	309	293
Vimy	1703	1434	19.5	18.9	327	266
Watson	1751	1604	19.1	20.1	337	318

Data is summarized but was not analysis over all sites due to heterogeneity of variance

Table 26. Variety and Seeding Method in All Fields in 2003 Indexed to the field average=100

	Salvaged Straw kg ha^{-1}		Fiber Content (%)		Fiber Yield based on Salvaged straw kg ha^{-1}	
	Hoe	Sweeps	Hoe	Sweeps	Hoe	Sweeps
Arras	100	100	100	100	100	99
Bethune	**134**	**143**	**106**	**106**	**141**	**153**
Carnduff	123	127	111	103	133	130
Flanders	**121**	**138**	**120**	**114**	**145**	**157**
Hala	78	90	97	94	73	84
Hanley	**126**	**130**	**114**	**107**	**142**	**140**
Hermes	227	251	151	152	338	391
Lightning	131	139	97	100	125	138
Linola1084	**124**	**112**	**127**	**124**	**154**	**138**
Linola2047	**136**	**137**	**106**	**99**	**140**	**135**
Linola2090	102	100	114	111	114	111
Macbeth	130	157	96	95	123	146
Mons	128	144	102	102	129	147
Norlin	124	123	112	111	137	136
Normandy	91	110	103	104	91	115
Nugget	**127**	**137**	**115**	**108**	**145**	**147**
Omega	131	133	110	107	141	141
Taurus	129	164	108	112	138	186
Valour	106	103	104	100	109	102
Vimy	127	150	111	101	138	152

Table 27. Summary of 2004 fiber traits all sites trial 3 based percent of field average=100						
	Salvaged Straw kg ha^{-1}		Fiber Content (%)		Fiber Yield Based On Salvaged Straw kg ha^{-1}	
Arras	81	98	94	97	74	94
Bethune	104	109	97	99	98	107
Carnduff	92	84	92	93	86	79
Flanders	77	93	104	106	78	97
Hala	88	65	92	93	79	60
Hanley	105	93	103	104	108	95
Hermes	147	165	121	129	176	207
Lelystad	114	121	122	121	139	146
Lightning	108	101	92	92	98	89
Linola1084	89	93	112	110	100	101
Linola2047	95	89	95	96	89	85
Linola2090	82	81	94	94	77	76
Macbeth	94	103	92	91	85	92
Mons	85	86	88	95	74	83
Natsja	148	137	109	102	158	140
Norlin	96	96	107	104	103	101
Normandy	96	104	94	93	90	93
Nugget	97	98	102	99	96	97
Omega	92	97	103	97	92	93
Redwood 65	112	126	94	96	103	120
Somme	88	86	96	97	85	83
Taurus	100	100	95	96	95	95
Valour	99	93	99	97	99	88
Vimy	103	85	103	96	105	80
Watson	106	95	100	102	108	96

Table 28. Impact of straw management options on retting 2003

-Results from Regression Equations

CANORA Shake Test Result = f(Treatment)

	Shake Test Result	
HTR1	2.6	
HTR4	2.6	
HTR3	2.4	
HTR2	2.1	*

**denotes significant difference to HTRT3*

ALL FIELDS Shake Test Result = f(Treatment)

	Shake Test Result	
HTR4	0.5	
HTR2	0.5	
HTR3	0.4	*
HTR1	0.4	*

**denotes significant difference to HTRT4*

Shake Test Result = f(Location)

	Shake Test Result	
Canora	2.4	
Indian Head	0.4	*
Redvers	0.3	*

**denotes significant difference to Canora*

ALL FIELDS Shake Test Result = f(Treatment)

	Shake Test Result	
Samples Sent in Spring 2004	2.4	
T=8	0.5	*
T=0	0.4	*
T=3	0.3	*
T=4	0.3	*
T=2	0.3	*
T=1	0.2	*

**denotes significant difference to Samples Sent in 2004*

Fiber Content (%) = f(Location)

	Fiber Content (%)	
Canora	30.2%	
Indian Head	16.3%	*
Redvers	15.3%	*

*denotes significant difference to Canora

Fiber Content (%) = f(Time of Collection)

	Fiber Content (%)	
Spring 2004	30.2%	
2nd of Fall 2003	16.5%	*
1st of Fall 2003	15.7%	*

*denotes significant difference to Canora

1. Harvest (combine) the crop as low as possible to the soil and then roll the field with a pea roller or to press the straw to the ground.
2. Harvest (combine) the crop as low as possible to the soil and do not press into the soil (use the same harvest equipment as in #1).
3. Strip the seed or simply cut as low as possible to the soil with a sickle bar mower and roll to ensure contact with the soil.
4. Cut with a disc mower and roll or simply cut with a disc mower and then roll (a sickle bar haybine can be used by set as close to the soil as possible 2-4 cm).

Table 29 Impact of "harvest" time on average retting level
INDIAN HEAD (0.0 to 3.0)

	Shake Test Result	Sig?
Time 5 (3-Jun-2005)	1.8	*
Time 4 (25-May-2005)	1.6	*
Time 3 (20-May-2005)	1.4	*
Time 2 (9-May-2005)	1.2	*
Time 1 (15-Apr-2005)	1.1	*
Time 0 (12-Nov-2004)	*0.1*	

denotes significant difference* ***to Time 0 (12-Nov-04)*

REDVERS (0.0 to 3.0)

	Shake Test Result	Sig?
Time 10 (6-Jun-2005)	2.2	*
Time 5 (25-May-2005)	2.0	*
Time 9 (3-Jun-2005)	2.0	*
Time 12 (10-Jun-2005)	2.0	*
Time 6 (30-May-2005)	1.8	*
Time 7 (1-Jun-2005)	1.7	*
Time 11 (7-Jun-2005)	1.7	*
Time 3 (18-May-2005)	1.7	*
Time 8 (2-Jun-2005)	1.7	*
Time 4 (19-May-2005)	1.6	*
Time 1 (8-Apr-2005)	1.6	*
Time 2 (12-May-2005)	1.5	*
Time 0 (13-Oct-04)	*0.6*	

**denotes significant difference to Time 0 (13-Oct-04)*

INDIAN HEAD Fiber Content (%)

	Fiber Content (%)	Sig?
Time 5 (3-Jun-2005)	27.1	*
Time 4 (25-May-2005)	27.0	*
Time 3 (20-May-2005)	26.0	*
Time 2 (9-May-2005)	24.5	*
Time 1 (15-Apr-2005)	23.4	*
Time 0 (12-Nov-2004)	*20.2*	

**denotes significant difference to Time 0 (12-Nov-04)*

REDVERS Fiber Content (%)

	Fiber Content (%)	Sig?
Time 10 (6-Jun-2005)	28.5	*
Time 5 (25-May-2005)	27.6	*
Time 9 (3-Jun-2005)	27.4	*
Time 12 (10-Jun-2005)	27.3	*
Time 6 (30-May-2005)	26.9	*
Time 7 (1-Jun-2005)	26.8	*
Time 11 (7-Jun-2005)	26.6	*
Time 3 (18-May-2005)	26.4	*
Time 8 (2-Jun-2005)	26.4	*
Time 4 (19-May-2005)	26.0	*
Time 1 (8-Apr-2005)	25.3	*
Time 2 (12-May-2005)	24.1	*
Time 0 (13-Oct-04)	*19.7*	

**denotes significant difference to Time 0 (13-Oct-04)*

***REDVERS* Fiber Content (%) = f(Treatment)**

	Fiber Content (%)	Sig?
HTRT 1	26.7	
HTRT 2	27.0	
HTRT *4*	*26.2*	
HTRT 3	*24.4*	*

**denotes significant difference to HTRT 1*

Harvest treatment HTRT description

1. Harvest (combine) the crop as low as possible to the soil and then roll the field with a pea roller or to press the straw to the ground.
2. Harvest (combine) the crop as low as possible to the soil and do not press into the soil (use the same harvest equipment as in #1).
3. Cut as low as possible to the soil with a sickle bar mower (2-4 cm) and roll to ensure contact with the soil
4. Cut with a disc mower and roll or simply cut with a disc mower and then roll (a sickle bar haybine can be used by set as close to the soil as possible 2-4 cm).

Table 30 Level of Retting of Treatments at various collection times

Redvers 2004

	Intercept (13-Oct-04)	Time 1 (13-Oct-2004)	Time 2 (8-Apr-2005)	Time 3 (12-May-2005)	Time 4 (18-May-2005)	Time 5 (19-May-2005)	Time 6 (25-May-2005)	Time 7 (30-May-2005)	Time 8 (1-Jun-2005)	Time 9 (2-Jun-2005)	Time 10 (3-Jun-2005)	Time 11 (6-Jun-2005)	Time 12 (7-Jun-2005)
HTRT1	0.5	1.7	2.2	1.8	1.7	2.1	1.9	2.0	1.8	2.0	2.3	1.6	2.1
HTRT2	0.4	1.9	**1.3**	1.6	1.7	1.9	1.9	**1.7**	1.6	2.0	2.4	1.8	2.3
HTRT3	0.7	1.4	**1.0**	**1.3**	1.6	1.9	**1.6**	**1.4**	1.6	1.8	2.3	1.7	**1.7**
HTRT4	0.7	1.4	**1.4**	2.0	1.5	2.3	1.9	1.8	1.7	2.3	**1.7**	2.2	2.0

NOTE: HTRT1 was used as intercept, bolding denotes significantly different from intercept

Indian Head 2004

	Time 0 (12-Nov-2004)	Time 1 (15-Apr-2005)	Time 2 (9-May-2005)	Time 3 (20-May-2005)	Time 4 (25-May-2005)	Time 5 (3-Jun-2005)
HTRT1	0.1	1.2	1.2	1.4	1.9	1.9
HTRT2	0.1	1.1	1.3	1.5	**1.5**	1.7
HTRT3	0.1	**1.0**	1.1	1.4	**1.5**	1.9
HTRT4	0.1	1.1	1.2	1.4	**1.5**	1.8

NOTE: HTRT1 was used as intercept, bolding denotes significantly different from intercept

Table 31. Growing season monthly mean temperatures (°C) and accumulated precipitation (mm) measured at Indian, Canora and Redvers during 2003 and 2004.

	Indian Head		Canora		Redvers	
yr/mth	Mean T (°C)	Tot Precip (mm)	Mean T (°C)	Tot Precip (mm)	Mean T (°C)	Tot Precip (mm)
2003-04	4.3	61.6	3.5	17.3	5.0	18.8
2003-05	11.4	23.6	12.5	31.5	11.7	50.2
2003-06	15.5	18.0	16.6	28.7	16.3	34.9
2003-07	18.6	23.4	18.5	61.0	19.4	27.2
2003-08	19.5	10.6	20.1	8.8	20.9	35.5
2003-09	10.6	17.6	15.1	34.0	11.9	12.9
2004-04	3.7	17.1	4.7	10.6	4.2	33.2
2004-05	6.8	104.8	7.0	82.6	7.3	96.8
2004-06	12.6	85.0	13.3	57.2	13.8	89.4
2004-07	16.3	75.4	17.1	64.0	17.3	72.8
2004-08	13.1	71.2	13.7	98.3	13.7	54.5
2004-09	11.5	6.6	na	na	12.5	19.3

Technology Transfer Supplement Report
To
The Agriculture Development Fund
For
Project 2002 0218
Adding Value to Flax Production with Fiber Agronomy

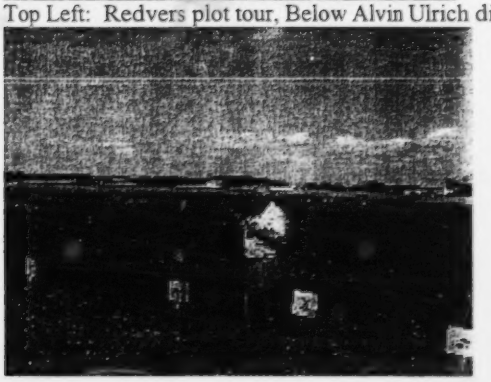
Project Administrator
Kim Stonehouse
East Central Research Foundation
Canora

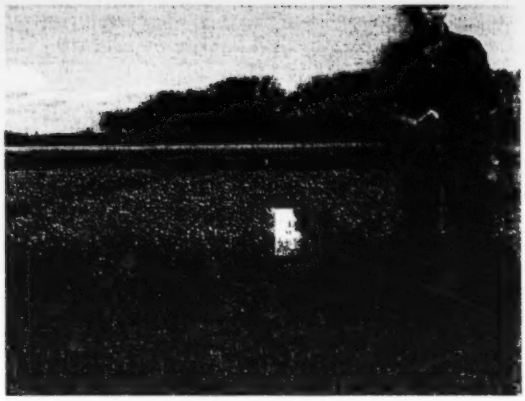
Technology Transfer events

Field Days

During the field seasons of the trial, field days were held each summer in July at the collaborators' respective sites. The trial was a dedicated tour stop during the tour with industry partners invited to speak about the trial. Alvin Ulrich and Richard Marleau from Biolin were invited to speak at Redvers, Canora and Indian Head during the tours.
Byron Irvine from AAFC and lead scientist with the project also lead the presentations at the field day.

Top Left: Redvers plot tour, Below Alvin Ulrich discusses Fiber production in Saskatchewan.





Kim Stonehouse poses with Agronomy trials at ECRF field day 2004.

Public events

A number of speaking engagement where the project was discussed in detail. At the Soils and Crops Workshop at the University of Saskatchewan 2005, Richard Marleau from Biolin discussed the Fiber industry and results based on the trials supported by ADF in this project. Richard Marleau also delivered a seminar on fiber and the related trials at the South East Research Farm Winter meeting at Redvers 2004.

Formal publications

AAFC Byron Irvine is in the process of developing a manuscript for scientific publication on behalf and in cooperation with the collaborators of the project. The final report in its entirety will be posted on the Agri-ARM website for public availability.

The ADF was gratefully acknowledged for its support of the project during the delivery of each public event.